Comparison of Plant and Animal Cells

Observation under the light microscope of onion epidermis, Elodea leaf and human cheek cells

Duration	2 hours
Work format	Pairs (microscope) with individual cheek-cell sampling and individual report
Level	First-year undergraduate, Cell Biology module
Name(s) / Group	
Date	

1. Introduction

All living organisms are made of cells, but not all cells look alike. Plant and animal cells are both eukaryotic: each has a nucleus enclosed by a membrane, a cytoplasm, and a plasma membrane. They also differ in several important ways that reflect how each organism lives. Plant cells are surrounded by a rigid cell wall, usually contain a large central vacuole, and, in green tissues, carry chloroplasts. Animal cells have no wall, no large central vacuole and no chloroplasts.

In this practical session you will prepare your own slides, observe three types of cells with a light microscope, draw what you see to scale, and compare the structures you can identify. You will also test how each cell type reacts to pure water, which links cell structure to function.

Learning objectives

By the end of this session you should be able to:

- Prepare a fresh wet mount and use a light microscope correctly (x10 and x40 objectives).
- Identify the nucleus, cytoplasm, plasma membrane, cell wall, vacuole and chloroplasts when they are visible.
- Produce an accurate, labelled and scaled biological drawing.
- Compare plant and animal cells and relate their structures to their functions.
- Explain why plant and animal cells behave differently in a hypotonic solution (pure water).

2. Materials and Reagents

Category	Items (per pair of students)
Biological material	Red or white onion bulb (inner scale) Elodea (Egeria densa) fresh leaves; spinach or lettuce leaf if Elodea is unavailable Human cheek cells (own sample, one clean cotton swab or toothpick per student)

Category	Items (per pair of students)
Equipment	Light microscope with x10 and x40 objectives Glass slides and coverslips Fine forceps, scalpel or razor blade, dissecting needle Dropper or Pasteur pipette Filter paper or paper towel Ruler (transparent, in mm) for field-of-view measurement
Solutions	Distilled water (or tap water if not available) Methylene blue 0.1 % (or diluted iodine tincture, or diluted blue ink) Physiological saline, NaCl 0.9 % (9 g of salt in 1 L of water)
Waste and hygiene	Beaker with diluted bleach (about 1 %) for used slides, coverslips and swabs Gloves (optional) and hand soap

Low-cost alternatives

No methylene blue: use a drop of diluted iodine tincture from a pharmacy, or very dilute blue ink.

No Elodea: use a thin peel from the underside of a spinach leaf, or a fine edge of a lettuce leaf, to see chloroplasts.

No saline solution: dissolve about 9 g of kitchen salt in 1 L of water.

3. Safety and Hygiene Rules

- Each student uses only their own sample. A new, clean cotton swab or toothpick is used by each student, and nothing is shared.
- Never pipette with the mouth. Wash your hands before and after the session.
- Handle blades and scalpels with care, always cutting away from your fingers.
- Used slides, coverslips, swabs and toothpicks go into the beaker of diluted bleach, not into the ordinary bin.
- Methylene blue and iodine stain skin and clothes: avoid contact and rinse with water if needed.
- Clean the microscope stage and objectives with lens paper at the end. Turn the lamp off and lower the stage.

4. Experimental Protocol

Part A. Onion epidermal cells (plant cells)

1. Cut a small piece (about 1 cm^2) from an inner scale of the onion.
2. Using forceps, peel off the thin, transparent skin from the inner (concave) surface.
3. Place it flat in a drop of water on a clean slide. Make sure it does not fold.
4. Lower a coverslip at an angle with the needle to avoid air bubbles.
5. Observe first at x10, then at x40. Identify the cell wall, nucleus, cytoplasm and vacuole. If you use red onion, note the colour of the vacuole.

6. Add a drop of iodine (or methylene blue) at one edge of the coverslip and draw it under with filter paper placed on the opposite edge. Observe again and note what is now easier to see.
7. Draw 2 to 3 adjacent cells at x40 (see Section 5 for drawing rules).

Part B. Elodea leaf cells (plant cells with chloroplasts)

1. Detach a young leaf from the tip of an Elodea shoot with forceps.
2. Mount it whole in a drop of water on a slide and cover with a coverslip.
3. Observe at x10, then at x40, focusing on a few cells in the middle of the leaf.
4. Identify the cell wall, the numerous green chloroplasts and the large central vacuole.
5. Watch the chloroplasts for 1 to 2 minutes. Under a warm lamp, they may move along the cell periphery (cytoplasmic streaming, or cyclosis). Record whether you observe movement.
6. Draw 2 to 3 adjacent cells at x40.

Part C. Human cheek cells (animal cells)

1. Rinse your mouth with water. Gently scrape the inside of your cheek 3 to 4 times with a clean cotton swab or toothpick.
2. Spread the sample in a thin smear in a drop of physiological saline (0.9 % NaCl) on a slide. Do not use pure water at this stage.
3. Add one small drop of methylene blue and wait 1 minute.
4. Lower a coverslip carefully and remove the excess liquid with filter paper.
5. Observe at x10 to find isolated cells, then at x40. Identify the nucleus (dark blue), the cytoplasm (pale blue) and the plasma membrane (thin outline).
6. Note the absence of a cell wall, a large vacuole and chloroplasts.
7. Draw 2 to 3 cells at x40.
8. Place the used slide, coverslip and swab in the bleach beaker.

Part D. Effect of pure water on plant and animal cells

The aim is to compare how the two cell types respond to a hypotonic solution.

1. Prepare one new cheek-cell slide in 0.9 % NaCl as in Part C, and one new onion epidermis slide in water, then observe both to confirm normal shape.
2. On each slide, add a drop of distilled water at one edge of the coverslip and draw it under with filter paper at the opposite edge. Repeat once or twice to replace the medium.
3. Observe immediately and then after 3 to 5 minutes. Describe any change in shape or volume, and any cell that appears swollen, burst or unchanged.
4. Record your observations in Table 3.

Tip for a clear result

Animal cells often swell and may lyse (burst) in pure water because they have no wall. Plant cells stay intact because the cell wall resists the pressure of the incoming water, and the cell becomes turgid.

If cheek cells are hard to see after the change, look at the edge of the coverslip where the water arrives first.

5. How to Make a Scientific Drawing

- Use a sharp pencil and a white page. Draw only what you see, not what the textbook shows.
- Draw clear, continuous lines. No shading and no colouring, except where colour is the observation (for example the red vacuole of red onion).
- Give the drawing a title, the type of cell, the objective used and the total magnification (objective x eyepiece).
- Use ruled label lines that do not cross each other, and write labels horizontally, to the right of the drawing.
- Add a scale bar. To obtain it, measure the diameter of the field of view at x10 with a transparent ruler (in mm), then deduce the field at x40 (the field is 4 times smaller).

6. Results

Table 1. Microscope calibration and cell size

Diameter of the field at x10: _____ mm Diameter of the field at x40: _____ mm

Cell type	Number of cells across the field (x40)	Estimated cell length (µm)	Remarks
Onion epidermal cell			
Elodea leaf cell			
Human cheek cell			

Estimated length (µm) = field diameter at x40 (µm) divided by the number of cells aligned across the field.

Table 2. Comparison of structures observed

Write Yes or No for each structure, and add a short description of what you saw.

Feature	Onion cell	Elodea cell	Cheek cell
Cell shape			
Cell wall			
Plasma membrane visible			

Feature	Onion cell	Elodea cell	Cheek cell
Nucleus (position)			
Large central vacuole			
Chloroplasts			
Cytoplasmic streaming			
Approximate size (µm)			

Table 3. Reaction to pure water (hypotonic solution)

Observation	Cheek (animal) cells	Onion (plant) cells
In normal medium		
Immediately after adding water		
After 3 to 5 minutes		
Interpretation		

Biological drawings

Attach your three labelled drawings (onion, Elodea, cheek cells) on separate sheets, each with title, magnification and scale bar.

7. Questions for the Report

1. List the structures that are common to plant and animal cells in your observations. What is the function of each?
2. List the structures that you saw only in plant cells. Explain the role of the cell wall, the central vacuole and the chloroplasts.
3. Why did the onion epidermal cells contain no chloroplasts, whereas Elodea cells did? What does this tell you about cell specialisation?
4. Why was the nucleus easier to see after staining? What does methylene blue bind to?
5. Cheek cells were mounted in 0.9 % NaCl rather than in pure water. Explain this choice using the terms isotonic and hypotonic.
6. Explain, with reference to osmosis and the cell wall, why animal cells may burst in pure water while plant cells do not. What name is given to the state of a plant cell full of water?

7. Using your size measurements, which cell type is the largest? Do your values agree with what you expect from a textbook? Give two possible sources of error in your measurements.
8. Name one limitation of the light microscope in this practical (for example organelles that you could not see) and the technique that would be needed to observe them.

8. Conclusion

Write a short conclusion (5 to 8 lines) summarising the main similarities and differences between plant and animal cells that you observed, and linking each major difference to the way the cell functions.

9. Assessment Rubric (20 points)

Criterion	Points	What is expected
Preparation of slides and handling of the microscope	4	Clean mounts without bubbles, correct focusing, safe and tidy handling, correct disposal of waste.
Quality of biological drawings	4	Accurate, clear lines, correct labels, title, magnification and scale bar.
Results tables (1, 2 and 3)	4	Complete, consistent with the observations, measurements with units.
Answers to questions	6	Correct use of terms, clear explanations of osmosis, wall, vacuole and chloroplasts.
Conclusion, presentation and English	2	Clear structure, concise, correct scientific vocabulary.
Total	20	

10. Notes for the Instructor

Preparation (before the session)

- Buy 2 to 3 onions (red onion gives the best contrast). Keep the bulbs whole and cut them only during the session.
- Keep Elodea in a jar of water in a bright place. It is sold cheaply in aquarium shops. Spinach or lettuce is a fallback.
- Prepare 1 L of 0.9 % NaCl (9 g of salt per litre) and a small bottle of 0.1 % methylene blue, or dilute iodine tincture.
- Prepare the bleach beaker in advance (about 1 % bleach in water).

Common difficulties

- Air bubbles: lower the coverslip slowly at an angle.
- Onion skin folded or too thick: use the thinnest, most transparent piece.
- Cheek cells overlapping in clumps: spread the smear thinner and look at the edges of clumps.

- Over-staining: wick away the excess dye with filter paper.

Possible extensions

- Plasmolysis of onion cells in 6 % NaCl, followed by deplasmolysis in water.
- Staining of starch in potato cells with iodine.
- Measurement of cell sizes with a calibrated eyepiece micrometer if available.